



# The determinants of ASEAN-5 real effective exchange rate *vis-à-vis* the UK pound

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## Abstract

**Purpose** – The purpose of this paper is to present an empirical analysis of long-run and short-run forcing variables of purchasing power parity (PPP) for ASEAN-5 currencies *vis-à-vis* the UK pound, i.e. their real effective exchange rate (REER).

**Design/methodology/approach** – This study uses a recently developed autoregressive distributed lag (ARDL) approach to co-integration (Pesaran *et al.*, 2001) over the period 1991:Q1-2006:Q2. Our empirical results suggest that the foreign interest rate ( $R^*$ ) and domestic money supply (M1) are the significant long-run forcing variables of PPP for ASEAN-5 REERs for the three periods.

**Findings** – In the short-run, the variables have different impacts during the sub-periods and full period for ASEAN-5 countries. The results suggest that the domestic money supply (M1) for Malaysia, domestic interest rate and foreign interest rate ( $R^*$ ) for Indonesia, domestic money supply (M1) and term of trades (TOT) for Philippines, foreign interest rate ( $R^*$ ) for Thailand, and foreign interest rate ( $R^*$ ) and net foreign assets (NFA) for Singapore, respectively, have the highest significant short-run forcing variable of PPP for countries REERs.

**Originality/value** – In this respect, the outcomes can derive policy implication for the monetary authorities in these ASEAN-5 countries.

**Keywords** Economics, Globalization, Finance, ASEAN-5, Purchasing power parity (PPP), Real effective exchange rate

**Paper type** Research paper

## Introduction

The financial market situation of Southeast Asian Nations (Malaysia, Indonesia, Philippines, Thailand and Singapore, hereafter ASEAN-5, the initial members of the economic group when it was first established in 1967) countries is generally thin and reasonably shallow. This has caused the purchasing power parity (PPP) in each of these countries to become misaligned among them. For instance, if a country chooses a floating exchange rate, it is possible that its exchange rate can be excessively volatile due to speculation. The volatility of exchange rates generates uncertainties that can affect domestic and foreign investor's investment decisions. This dilemma continues to undermine the ASEAN-5 economic growth prospects. In contrast, if a country chooses a fixed exchange rate, it provides little space for its policymakers to manoeuvre and to realign its exchange rate with ASEAN-5 currencies.

The 1997 Asian Financial Crisis (AFC) plunged some of the most successful economies in the world, particularly ASEAN-5 countries, into financial chaos. This crisis caused collapse in these economies, i.e. the impact of the financial crisis was very severe not only on the financial sectors but also on the real sectors in these countries. Thus, the 1997 financial crisis was a critical point in Asian economic history. It was empirically and theoretically argued that the AFC caused the ASEAN-5 economies to



become more sensitive to changes and fluctuations in the world economy, particularly the economy of the UK. Therefore, the issue of the degree of sensitivity of ASEAN-5 to the UK economy will be measured in this study.

The objective of this study is: to determine the long-run and short-run forcing variables of PPP on ASEAN-5 real effective exchange rate (REER) over the study period and sub-periods. The autoregressive distributed lag (ARDL) approach is employed here because it has several advantages, such as: avoiding the classification of variable into  $I(0)$  or  $I(1)$ , it is free from problems of endogeneity and yields consistent estimates of the long-run coefficients. In this study, the emphasis will also be on the behaviour of the REER. (The term REER is defined as the real price in the domestic currency of one real unit of another (foreign) currency. Hence, the nominal exchange rate is part of the REER.) The REER indicates how the weighted average purchasing power of a currency has changed relative to some arbitrarily selected base period.

The findings of this study should be useful for the ASEAN-5 policy makers. In the light of the serious implication of the changes and fluctuations of exchange rates in ASEAN-5 economies, it is critically important to conduct a study on the PPP of REER determinants that have important impacts upon the economic growth of ASEAN-5.

### Overview of PPP

The PPP theory was originally developed by Cassel (1919/1923), a Swedish economist, who stated that the exchange rate of currencies between two countries would move proportionally to the ratio of the price level in the currencies concerned. There are an array of approaches and related methodological frameworks available in the PPP literature: MacDonald and Ricci (2001), Sarno and Taylor (2002), Cheung *et al.* (2004) and Che and Mansur (2006). However, there are at least four major competing PPP models that demand special attention (Cheung *et al.*, 2004). These are: absolute PPP and relative PPP, monetary model of PPP, portfolio balance of PPP and uncovered interest parity (UIP) of PPP.

### Absolute PPP and relative PPP

In the literature, there are two versions of PPP theory, namely, absolute PPP and relative PPP. While absolute PPP refers to the equity of price levels across countries, relative PPP refers to the equity of the rates of change in these price levels. The Law of Comparative Advantage (LCA) theorem of equilibrium exchange rate or the Law of One Price (LOP) of the capitalist system suggests that the same basket of goods and services must sell at the same price in different capitalist countries (Cassel, 1919/1923; Sarno and Taylor, 2002). This measure of the price of the basket of goods and services is essentially known as absolute PPP and has been repeatedly expressed in the literature (Sarno and Taylor, 2002; Che and Mansur, 2006) as:

$$S_t = P_t - P_t^* \quad (1)$$

where,  $s_t$  is the spot REER expressed as the domestic price of the foreign currency;  $p_t$  is the domestic price level, while  $p_t^*$  is foreign price level and  $t$  denotes the time period. MacDonald and Ricci (2001) and Sarno and Taylor (2002) asserted that Equation (1), which represented the absolute PPP theoretical framework, should be specified as a testable regression equation, expressed as:

$$s_t = \beta_0 + \beta_1(p_t - p_t^*) + \varepsilon \quad (2)$$

where  $\beta$  is constant variable and  $\varepsilon$  is a noise error term.

Sarno and Taylor (2002) and Che and Mansur (2006) transformed the Equation (2) as:

$$s_t = \beta_0 + \beta_1 v_t - \beta_2 p_t + \beta_3 p_t^* + \varepsilon \quad (3)$$

where  $v_t$  is the *ex-post* nominal exchange rate at time  $t$ .

They argued that if  $v_t p_t$  and  $p_t^*$  are non-stationary integrated processes of  $I(1)$ , the weak form (or random walk) PPP prevails, implying that the residual term:  $\varepsilon$  is  $I(0)$ . Adding symmetry, strong and absolute version of PPP prevails, if  $\beta_2 = 1$  and  $\beta_3 = -1$  where "homogeneity" conditions exist, theoretically.

In common with absolute PPP, relative PPP looks at the relationship between exchange rates and prices in terms of growth rates. Relative PPP may still hold, i.e. even if the exchange rate is not equal to the exact ratio of the price indices, it may at least be comparable to it. Dornbusch (1976) and Frenkel (1976), who pioneered the relative PPP suggested that the actual price levels must be considered under the new relative PPP theoretical framework instead of the price. The essence of their suggestions is that some of the actual domestic prices, i.e. commodity goods and services, do not necessarily change in accordance with foreign prices. In simple economics terms, the relative PPP points out that the changes in the foreign exchange rates must be equal to the changes in relative domestic prices (Che and Mansur, 2006). These changes may be due not only to exchange rates but also money supply ( $m$ ), real gross domestic products (RGDP), the level of interest rate ( $i$ ) and inflation rate ( $\pi$ ), respectively (Sarno and Taylor, 2002; Brissimis *et al.*, 2005).

### Monetary models

Monetary models are considered standard exchange rate determination models. They are based on the view that the exchange rate is the relative price of foreign and domestic money so it should be determined by the relative supply and demand for these moneys. Money market equilibrium condition resides on PPP, which explains the monetary models with the assumption of flexible prices.

Within the monetary models, there is the sticky-price monetary model with sluggish adjustment of prices in the goods markets. As deviations from strict PPP appeared in the short run, one of the major pillars of the flexible-price monetary model would be called into question. In response, Dornbusch (1976) constructed a sticky-price monetary model that allowed for short-run PPP deviations, and thus, the underpinning of Dornbusch-Frenkel Sticky-Price Monetary Model (DFSP) model:

$$\alpha_1 > 0, \alpha_2 < 0, \alpha_3 < 0, \alpha_4 > 0, \alpha_5 = \alpha_6 = 0$$

The sticky-price monetary model assumes that the PPP will hold in the long run (MacDonald and Taylor, 1994; Chinn and Meese, 1995; Kanas, 1997; Husted and MacDonald, 1998; Dutt and Ghosh, 1999; Francis *et al.*, 2001; Rapach and Wohar, 2002; Groen and Kleibergen, 2003), but not in the short run due to the price stickiness. The DFSP is generally re-expressed (Baillie and McMahon, 1990; Taylor, 1995; Che and Mansur, 2006) as:

$$s_t = \alpha_0 + \alpha_1 m_t + \alpha_2 G_t + \alpha_3 i_t + \alpha_4 \pi_t + \dots + \varepsilon \quad (4)$$

The monetary models of exchange rate determination are concentrated in terms of expected future value and the current exogenous variables. Taylor (1995) stated that

the exchange rate was a function of expectation of discounted future value of exogenous variables. There are different processes involved for exogenous variables to follow different paths of exchange rates. According to Baillie and McMahon (1990), Taylor (1995) and Che and Mansur (2006), Equation (4) can be reformulated for this study as follows:

$$S_t = \alpha_0 + \alpha_1 R + \alpha_2 R^* + \alpha_3 M + \alpha_4 G + \alpha_5 \pi + \alpha_6 NFA + \alpha_7 TOT + U_1 \quad (5)$$

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where  $S_t$  is the REER in the ASEAN-5 countries with the UK,  $R$  is the domestic interest rate in the ASEAN-5 countries,  $R^*$  is the foreign interest rate,  $M$  is the money supply in the ASEAN-5 countries,  $\pi$  is the inflation rate,  $NFA$  is the net foreign asset in the ASEAN-5 countries,  $G$  is the real gross domestic product in the ASEAN-5 countries, and  $TOT$  is the term of trade in the ASEAN-5 countries.

### Portfolio balance model

The portfolio balance model is one of the major models based on PPP. According to the portfolio balance model, exchange rates are determined by the demand and supply of all domestic and foreign assets, and not just by the supply and demand of money, as in the monetary model. The portfolio balance model is therefore a dynamic model of exchange rate determination based on the interaction of goods and service markets, current account balance, prices and the rate of asset accumulation.

The composite IS-LM model of Edwards (1989) had empirically observed that the key factors that could significantly influence the exchange rate of a country's currency were related to the country's stage of development and the state of openness of the economy. Earlier researchers, such as Clerk and Macdonald (1999), Stein (1999), Obstfeld and Rogoff (1995), Cavallo and Ghironi (2002) and Che and Mansur (2006), had attempted to integrate the earlier models together. These researchers further integrated the various theoretical effects upon PPP based on the portfolio balance model and had also included the effects via interest rate, money supply ( $M$ ), inflation rates and the portfolio balance effects via economic growth rates, terms of trade ( $TOT$ ) and net foreign assets ( $NFA$ ), which had measured the openness of the economy. According to Che and Mansur (2006), the portfolio balance equation for this study could be reformulated as:

$$S_t = \alpha_0 + \alpha_1 R + \alpha_2 R^* + \alpha_3 M + \alpha_4 G + \alpha_5 \pi + \alpha_6 NFA + \alpha_7 TOT + U_t \quad (6)$$

### UIP model

The UIP model theory states that differences between interest rates across countries are explained by the expected change in currencies. In more recent empirical literature on exchange rates, a lot of effort has been devoted to testing international parity conditions, such as PPP and UIP, which have played an essential role in asset market models of the exchange rate (MacDonald and Taylor, 1990; Chaboud and Wright, 2005). Such conditions are normally thought of as arbitrage relationships, which are held continuously, especially in the case of UIP. The UIP equation is written as:

$$S_{t+k} = S_t + i_{t,k} \quad (7)$$

where  $S$  is the log exchange rate,  $i$  is the interest rate of maturity  $k$  and  $t$  is time to maturity. According to Bjorland and Hungness (2002), and Che and Mansur (2006):

$$\begin{aligned} s_{t+1} - s_t &= i_t - i_t^* \\ \Delta s_{t+1}^e &= i_t - i_t^* \end{aligned} \quad (8)$$

Assuming that  $\Delta s_{t+1}^e$  is a function of deviation of  $s_t$  from its equilibrium value  $s_t$ , Equation (8) can be rewritten as:

$$\Delta s_{t+1}^e = i_t - i_t^* = -\lambda(s_t - s_t^*) \quad (9)$$

In the long run, the equilibrium exchange rate will be given by relative price according to PPP. Hence, substituting Equation (1) ( $s_t = p_t - p_t^*$ ) for the equilibrium exchange rate will result in the following equation:

$$s_t = p_t - p_t^* - \theta(i_t - i_t^*) \quad (10)$$

Bjorland and Hungness (2002), and Che and Mansur (2006) transformed Equation (10) into a testable co-integration model yielding:

$$s_t = \beta_0 + \gamma_1 p_t + \gamma_2 p_t^* + \beta_3 \theta(i_t - i_t^*) + \varepsilon_t \quad (11)$$

where  $\beta$  and  $\gamma$  are the coefficient parameters, and  $\theta$  is the speed of adjustment of interest rate differential and  $\theta = 1/\lambda$ , suggesting that the real exchange rate is a function of both the price level and interest rates differentials. Equation (11) suggests that all real shocks that force real exchange rates away from PPP have to be captured by the long-run market interest rates, where the rates appear to predict PPP and exchange rate levels (MacDonald and Nagayasu, 2000; Caporale *et al.*, 2001; Bjorland and Hungness, 2002; Jin, 2003; Wang, 2004; Che and Mansur, 2006).

## Methodology of the study

### Source of data

Our estimates on this study were based on the most up-to-date quarter data for the sample period 1991:1Q-2006:2Q for Malaysia, Indonesia, the Philippines, Thailand and Singapore. The published quantitative financial and economic data were extracted from three main sources: the International Monetary Fund (IMF, various issues and home page), central banks of ASEAN-5 countries, and various issues of reports published. The data acquired from the above sources was compared with the data extracted from DataStream (UUM online library software).

All value entities are defined in terms of national currencies. The models' variables are generated to a percentage quarter data. Che and Mansur (2006) believed that the span of the selected period is long enough to empirically test the long-run forcing variables influencing the co-integration PPP relationship in the economies under review.

### Model specification

In this paper, the exchange rate model was applied to explore the forcing factors that determine REER to the ASEAN-5 countries. However, Frenkel (1978), Edison (1985),

Dibooglu and Enders (1995), Baharumshah and Mohd (1997), Salehizadeh and Taylor (1999), Goh Soo and Mithani (2000), Azali and Zubaidi (2001), Taylor (2002), Sarno and Taylor (2002), Baharumshah and Lim (2004), Chaboud and Wright (2005) and Che and Mansur (2006) found that many earlier empirical researchers on the exchange rate adopted co-integration techniques.

Using the existing theoretical frameworks discussed earlier, we can write the PPP of equilibrium exchange rates based on the earlier empirical frameworks (models) as follows:

$$S_t = \alpha_0 + \alpha_1 R + \alpha_2 R^* + \alpha_3 M + \alpha_4 G + \alpha_5 \pi + \alpha_6 NFA + \alpha_7 TOT + \varepsilon_t \quad (12)$$

where  $S_t$  denotes the REER in ASEAN-5 countries via the UK,  $R$  denotes domestic interest rate in ASEAN-5 countries,  $R^*$  denotes foreign interest rate,  $M$  denotes the money supply in ASEAN-5 countries,  $\pi$  denotes the inflation rate,  $NFA$  denotes net foreign asset,  $G$  denotes real gross domestic product, and  $TOT$  denotes the term of trade. (According to Dufrenot and Yehoue (2005) and Che and Mansur (2006), REER was defined as the ratio of the domestic CPI to the foreign CPI. The deflator employed by researchers is varied: some employ the trade weighted average (TWA), while others employ the GNP deflator, etc.)

The disturbance term  $\varepsilon$  is to capture the unobserved effects and is assumed to have zero mean and constant variance.

## Econometric method

### *Unit root test: test for stationary*

The recent economic developments in econometrics warrant an examination of the characteristics of time series. The researchers Nelson and Plosser (1982) stated that the application of standard methods of conventional non-stationarity data containing any unit root problem may lead to spurious correlation in the regression analysis. The stationary test commonly known as the unit root test is conducted to check the order of the integration of each variable that is the number of times they must be differenced before attaining stationary status. In order to avoid the problem of spurious correlation in the regression analysis, the time series properties of the variables used in the regression analysis of this study are investigated using the two most popular unit root tests proposed to examine the stationary, which are the augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests.

### *ARDL*

Pesaran *et al.* (1996, 2001), Pesaran and Pesaran (1997) and Pesaran and Shin (1999) developed a procedure called ARDL. The ARDL approach also allows us to identify long-run and short-run dynamics explanatory variables on a dependent variable. It can be applied regardless of the stationary properties of the variables in the sample and it allows for inferences on long-run estimates, which is not possible under alternative co-integration procedures.

The first step in the ARDL procedure outlined by Pesaran and Shin (1999) is to test the long-run significance of the dependent variables by computing the  $F$ -statistic test, the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model. This is similar to testing the significance of the error correction term in an error correction model. It involves the testing of the joint long-run significance of all explanatory variables, including the constant.

We apply the ARDL approach proposed by Pesaran *et al.* (2001) to estimate Equation (12). The following ARDL model is estimated to examine the long-run relationship:

$$\begin{aligned}\Delta S = & \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 R_{t-1}^* + \alpha_3 M_{t-1} + \alpha_4 G_{t-1} + \alpha_5 \pi_{t-1} + \alpha_6 NFA_{t-1} + \alpha_7 TOT_{t-1} \\ & + \beta_1 \sum_{i=1}^n \Delta S_{t-i} + \beta_2 \sum_{i=0}^n \Delta R_{t-i} + \beta_3 \sum_{i=0}^n \Delta R_{t-i}^* + \beta_4 \sum_{i=0}^n \Delta M_{t-i} + \beta_5 \sum_{i=0}^n \Delta G_{t-i} \\ & + \beta_6 \sum_{i=0}^n \Delta \pi_{t-i} + \beta_7 \sum_{i=0}^n \Delta NFA_{t-i} + \beta_8 \sum_{i=0}^n \Delta TOT_{t-i} + \varepsilon\end{aligned}\quad (13)$$

where  $S$  is the REER,  $R$  and  $R^*$  are domestic interest rate and foreign interest rate, respectively.  $M$  is money supply,  $\pi$  is inflation rate,  $NFA$  is net foreign assets,  $G$  is growth rate of real gross domestic product in ASEAN-5 and  $TOT$  is term of trade.  $\Delta$  is the first difference,  $n$  is the lag number in the independent variables  $\sum_{i=1}^n$  and  $\varepsilon$  is the error term.

The main advantages of this procedure are: firstly, there is no prior endo-exogenous division of variables; second, no zero restrictions are imposed, and finally, there is no strict economic theory within which the model is grounded. The ARDL approach also allows us to identify long-run and short-run dynamics explanatory variables on a dependent variable.

## Empirical results

### Unit root test

In this study, we utilized the two most popular unit root tests, the ADF and PP tests, to check if the variables under consideration were integrated for  $I(0)$ ,  $I(1)$ , or mutually integrated. It is widely known that if any variable in the model is integrated to an order higher than  $I(1)$ , the ARDL technique cannot be used to provide reliable estimates of the parameters of the model.

ADF and PP tests suggest that most of our variables for ASEAN-5 economies are integrated in order  $I(0)$  or  $I(1)$ , which means that the null hypothesis of unit root is rejected for all series in both ADF and PP tests. Thus, we relied on the ARDL approach to estimate and interpret the parameters of the models used in the present study.

## Long-run equilibrium estimation

### Malaysia

Given the existence of a long-run relationship, the next step is to use the ARDL approach to estimate the parameters of this long-run relationship. This method has the additional advantage of yielding consistent estimates of the long-run coefficients that are asymptotically normal, irrespective of whether the variables under consideration are  $I(0)$ ,  $I(1)$  or fractionary integrated (Pesaran and Shin, 1999; Pesaran *et al.*, 2001).

The results of the ARDL models are reported in Table I. As we can see from the table, most of the variables under consideration are significant and the signs are consistent with a priori expectations. Clearly, for Malaysia, the key long-run forcing variables of PPP of REER against the UK pound throughout the sub-period and the whole period are observed to be the foreign interest rate ( $R^*$ ). The domestic money supply ( $M1$ ),  $NFA$  and  $TOT$  also jointly serve as the second forcing variables in determining Malaysia's long-run PPP of REER, especially the full period and before the AFC.

Regressors	Study period	Dependent variable REER (S)	
		Coefficient [ <i>t</i> -ratio]	
		Pre AFC	During and post AFC
<i>R</i>			
<i>R</i> *	0.2624 [2.784]**	0.3034 [7.123]***	−0.5586 [−2.811]**
<i>M1</i>	0.6027 [2.840]**	0.2199 [4.902]***	
<i>G</i>			0.1008 [1.9854*
<i>π</i>	0.3740 [2.692]**		00.8184 [3.908]**
<i>NFA</i>	−0.1859 [−2.090]**	0.0872 [2.195]**	
<i>TOT</i>	0.1446 [4.731]***	0.8717 [4.013]**	
<i>C</i>	0.0109 [0.0955]	0.1385 [2.648]**	−0.1830 [−0.8548]
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

**Notes:** The *t*-ratios are reported in square brackets. The following notation applies: domestic interest rate (*R*), foreign interest rate (*R*\*), domestic money supply (*M*), real gross domestic product (*G*), inflation rate (*π*), net foreign assets (*NFA*) and terms of trade (*TOT*). \*, \*\*, \*\*\*Significant at the 1, 5, 10 per cent, respectively

**Table I.**  
The selected ARDL  
model: long-run  
coefficient estimation  
for Malaysia REER  
via the British pound

According to Che and Mansur (2006), this can be explained as follows. Malaysia historically earned its monetary policy independence in June 1967. Prior to this date, it began to develop its own financial system, diversify its economy and started to export more of its products to other countries, particularly the UK, the USA, Japan and Europe. It thus began to accumulate a large amount of foreign reserve, particularly UK pounds, besides other currencies, as its foreign reserves to stabilized its economy.

### Indonesia

In Table II, the Indonesia results are similar to those of Malaysia in that the key long-run forcing variables of PPP of REER against the US dollar throughout the study sub-period and the whole period are observed to be the foreign interest rate (*R*\*), domestic money supply (*M1*) and real gross domestic product (*G*). In addition, the inflation rate (*π*) jointly serves as the second forcing variable in determining Indonesia's long-run PPP of REER. The table also indicates that AFC has left a notable negative impact upon Indonesia's long-term PPP, as well as its economy. The crisis has brought a sharp increase in Indonesia's inflation (Che and Mansur, 2006).

Regressors	Study period	Dependent variable REER (S)	
		Coefficient [ <i>t</i> -ratio]	
		Pre AFC	During and post AFC
<i>R</i>			
<i>R</i> *	0.09631 [2.008]*	−0.0661 [−3.565]**	0.1767 [5.617]***
<i>M1</i>	−0.8330 [−2.851]**	−0.0126 [−2.028]*	0.0331 [1.968]*
<i>G</i>	0.1094 [7.220]***	0.1697 [8.682]***	−0.2319 [1.944]*
<i>π</i>	0.0074 [1.787]*	−0.0088 [−2.807]**	
<i>NFA</i>			0.0290 [2.915]**
<i>TOT</i>			0.1197 [2.534]**
<i>C</i>	−0.2246[−3.884]***	0.0081 [1.849]*	−0.0592 [−1.183]
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

**Table II.**  
The selected ARDL  
model: long-run  
coefficient estimation  
for Indonesia REER  
via the British pound



*Philippines*  
The Philippines are partly affected by AFC, where the results in Table III show that key long-run forcing variables of PPP of REER throughout the sub-period and the whole period of the study are observed to be the domestic money supply (*MI*) and *TOT*. The foreign interest rate (*R\**) jointly serves as the second forcing variable in determining the Philippines' long-run PPP of REER. The results in Table III seem to suggest the Philippines had too much money in circulation in the market during the study as well as the sub-period; this is due to unstable socio- and political-economic conditions over a long period (Che and Mansur, 2006).

*Thailand*  
Thailand was the first ASEAN-5 economy attacked by the currency speculators in April 1996 and suffered as one of the worst victims among the ASEAN-5 members. Consequently, it was essentially forced to open its economy as one of the conditions prescribed by the IMF and the World Bank in order to assist with recovery funds (Che and Mansur, 2006). The statistics in Table IV indicate that its significant long-run forcing variables of PPP of REER are observed to be the domestic interest rate (*R*) and foreign interest rate (*R\**). The domestic money supply (*MI*) is a joint second significant long-run forcing variable of PPP of REER, especially before, during and after AFC.

**Table III.**  
The selected ARDL  
model: long-run  
coefficient estimation  
for Philippines REER  
via the British pound

Regressors	Study period	Dependent variable REER (S)	
		Coefficient [ <i>t</i> -ratio] Pre AFC	During and post AFC
<i>R</i>		0.1572 [6.784]***	
<i>R*</i>	0.2118 [1.712]*	0.4383 [3.828]**	
<i>MI</i>	0.1670 [8.516]***	−0.3136 [−3.624]**	0.2249 [14.73]***
<i>G</i>		−0.0738 [−3.277]**	
$\pi$	−0.2653 [−2.331]**	0.3354 [3.002]**	−0.3423 [−2.418]**
<i>NFA</i>			−0.2991 [−2.980]**
<i>TOT</i>	−0.6748 [−2.689]**	0.4296 [8.919]***	−0.1383 [−5.429]***
<i>C</i>	0.0300 [0.2150]		0.2188 [3.036]**
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

**Table IV.**  
The selected ARDL  
model: long-run  
coefficient estimation  
for Thailand REER  
via the British pound

Regressors	Study period	Dependent variable REER (S)	
		Coefficient [ <i>t</i> -ratio] Pre AFC	During and post AFC
<i>R</i>	−0.7069 [−1.929]*	−0.0983 [−4.976]***	0.1376 [4.930]***
<i>R*</i>	0.4460 [4.270]***	0.2491[9.425]***	−0.1602 [−3.834]**
<i>MI</i>		0.2180 [4.119]**	0.1917 [6.526]***
<i>G</i>	0.1002 [2.983]**		
$\pi$			
<i>NFA</i>	0.1035 [7.596]***		
<i>TOT</i>	0.1034 [11.52]***		
<i>C</i>	0.1654 [2.023]*	0.2601 [10.20]***	0.535 [17.67]***
The period no. of obs.	1991:Q2–2006:Q2 (61)	1991:Q2–1997:Q2 (25)	1997:Q3–2006:Q2 (35)

### Singapore

Singapore became a successful entreport city-state after its independence in 1973. Although the UK is its major trading partner, its strategic geographical location provides an opportunity for Singapore to be an international wholesale intermediary with many economies (Che and Mansur, 2006). The Singapore results in Table V indicate that the long-run forcing variables of PPP of REER are observed to be the foreign interest rate ( $R^*$ ), domestic money supply ( $M1$ ) and real gross domestic product ( $G$ ). Variables,  $NFA$ , and  $TOT$  jointly serve as the second forcing variables in determining Singapore's long-run PPP of REER.

### Error correction model (ECM)

We estimated the short-run dynamic of the REER model for ASEAN-5 using the ARDL approach to co-integration proposed by Pesaran *et al.* (2001). The explanatory statistics in ASEAN-5 indicated that the REER equations were well specified. None of the statistics in the Table VI-X were significant at the 5 per cent significance level. Thus the explanatory statistics test results obtained revealed that all equations passed the tests successfully, i.e. the  $\bar{R}^2$  showed that all the REER equations obtained best goodness-of-fits and the variation on the selected variables explained almost all the variations of the dependent variables for Malaysia, Indonesia, the Philippines, Thailand and Singapore against the UK pound under consideration. The standard error (SE) obtained best goodness-of-fits of the data, while DW showed normal distribution of the data for all ASEAN-5 REER equations.

In general, the results of the REER models for each of the ASEAN-5, as shown in Tables VI-X, indicate that the lagged error correction term  $ECM_1$  carries the expected negative signs and is highly significant, which is supportive of the inference of a unique co-integration and stable long run REER relationship. Moreover, the results of the significant short-run forcing variable of PPP for ASEAN-5 throughout the sub-period and the whole period are observed to be as follows:

For Malaysia, the key short-run forcing variables of PPP of REER against the UK pound throughout the sub-period and the whole period are observed to be the domestic money supply ( $M1$ ), while the domestic interest rate ( $R$ ) and the foreign interest rate ( $R^*$ ) jointly serve as the second forcing variables in determining Malaysia's short-run PPP of REER. In Table VI, Indonesia's results showed that the key short-run forcing variables of PPP of REER against the UK pound throughout the study sub-period and the whole period are observed to be the domestic interest rate ( $R$ ) and the foreign

Regressors	Study period	Dependent variable REER (S)	
		Coefficient [ <i>t</i> -ratio]	
		Pre AFC	During and post AFC
$R$		-0.1677 [-3.636]**	0.1531 [3.274]**
$R^*$	0.1510 [6.381]***	0.1616 [7.797]***	-0.1549 [-3.250]**
$M1$	-0.4648 [-5.083]***	-0.5711 [-4.968]***	-0.2017 [-2.173]**
$G$	0.7992 [3.913]***	0.9763 [4.014]**	0.2716 [2.077]**
$\pi$			-0.1430 [-2.425]**
$NFA$	0.1352 [2.538]**		0.1662 [2.518]**
$TOT$	-0.3362 [-1.737]*	0.2997 [2.765]**	
$C$	-0.0526 [-0.8185]	0.1727 [5.278]***	0.1637 [1.592]
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

**Table V.**  
The selected ARDL  
model: long-run  
coefficient estimation  
for Singapore REER  
via the British pound

**Table VI.**  
Error correction  
representation based  
on the ARDL model:  
short-run estimation  
for malaysia REER via  
the British pound

Regressors	Study period 1991:Q1-2006:Q2	Dependent variable REER (S) Coefficient [ <i>t</i> -ratio]	
		Pre AFC 1991:Q1-1997:Q2	During and post AFC 1997:Q3-2006:Q2
$ECM_{(-1)}$	-0.4157 [-3.816]***	-0.1357 [-9.523]***	-0.5225 [-4.572]***
$\Delta R$	0.1230 [2.680]**		-0.3044 [-1.927]*
$\Delta R^*$	0.4083 [2.520]**	0.3507 [4.720]***	
$\Delta M1$	0.1147 [2.715]**	0.1494 [2.941]**	0.1623 [2.916]**
$\Delta G$			
$\Delta \pi$			
$\Delta NFA$			
$\Delta TOT$	0.6433 [2.878]**	4121 [2.911]**	
$C$	0.0122 [0.21474]	0.2463 [7.394]***	0.1081 [1.315]
$\bar{R}^2$	0.7332	0.7510	0.7138
SE	0.0483	0.0145	0.0522
$S^2$ resid	0.1263	0.0042	0.0818
<i>F</i> -statistic	4.851	19.10	9.334
DW-statistic	1.926	2.273	2.057
The period no. of obs.	1991:Q2-2006:Q2 ( 61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

**Notes:** The *t*-ratios are represented in square brackets.  $\Delta$  Denotes the first difference of each variable. The following notation applies: domestic interest rate (*R*), foreign interest rate (*R*<sup>\*</sup>), domestic money supply (*M*), real gross domestic product (*G*), inflation rate ( $\pi$ ), net foreign assets (*NFA*) and terms of trade (*TOT*).  $\bar{R}^2$  is Adjusted *R*<sup>2</sup>, (SE) is the Standard Error of regression, and Sum squared residual. \*, \*\*, \*\*\*Significant at the 1, 5, 10 per cent, respectively

**Table VII.**  
Error correction  
representation based  
on the ARDL model:  
short-run estimation  
for Indonesia REER  
via the British Pound

Regressors	Study period 1991:Q1-2006:Q2	Dependent variable REER (S) Coefficient [ <i>t</i> -ratio]	
		Pre AFC 1991:Q1-1997:Q2	During and post AFC 1997:Q3-2006:Q2
$ECM_{(-1)}$	-0.3945 [-3.539]**	-0.5132 [-2.421]**	-0.5460 [-4.673]***
$\Delta R$	-0.2695 [-2.653]**	-0.0773 [-3.342]**	-0.2637 [-3.161]**
$\Delta R^*$	0.0347 [2.006]**	0.0258 [5.387]***	0.5688 [4.470]***
$\Delta M1$	-0.2556 [-2.673]**		-0.1017 [-3.942]**
$\Delta G$	0.4680 [4.907]***	0.1140 [8.481]***	0.5890 [3.471]**
$\Delta \pi$	0.0124 [3.216]**		
$\Delta NFA$	0.0178 [2.265]**		0.0346 [3.946]**
$\Delta TOT$			-0.1525 [-1.926]*
$C$	-0.1086 [-4.346]***	0.0020 [0.56421]	-0.1968 [-3.369]**
$\bar{R}^2$	0.87582	0.7478	0.8823
SE	0.0132	0.0012	0.0135
$S^2$ resid	0.0087	0.3501	0.0045
<i>F</i> -statistic	9.209	12.81	11.71
DW-statistic	1.863	1.720	2.227
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

interest rate (*R*<sup>\*</sup>). Variables, domestic money supply (*M1*) and *NFA* jointly serve as the second force in determining Indonesia's short-run PPP of REER.

The results in Table VIII for the Philippines show that the key short-run forcing variables of PPP of REER throughout the study sub-period and the whole period are

Regressors	Study period 1991:Q1-2006:Q2	Dependent variable REER (S) Coefficient [ <i>t</i> -ratio]	
		Pre AFC 1991:Q1-1997:Q2	During and post AFC 1997:Q3-2006:Q2
$ECM_{(-1)}$	-0.2984 [-5.079]***	-0.1293 [-7.578]***	-0.4178 [-4.679]***
$\Delta R$			
$\Delta R^*$		0.3409 [7.564]***	
$\Delta M1$	0.4594 [5.283]***	0.5670 [3.214]**	0.6133 [4.361]***
$\Delta G$		-0.2209 [-3.280]**	
$\Delta \pi$	-0.0780 [-2.261]**		-0.1240 [-2.193]**
$\Delta NFA$		-0.2420 [-4.740]***	
$\Delta TOT$	-0.1786 [-2.459]**	0.4340 [2.446]**	-0.3718 [-3.097]**
$C$	0.0572 [2.290]**	0.5558 [7.647]***	0.0914 [2.540]**
$\bar{R}^2$	0.7340	0.8593	0.7504
SE	0.0363	0.0105	0.0404
$S^2$ resid	0.0741	0.0016	0.0490
<i>F</i> -statistic	7.553	25.94	5.585
DW-statistic	1.934	2.197	1.920
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

**Table VIII.**  
Error correction  
representation based  
on the ARDL model:  
short-run estimation  
for Philippines REER  
via the British Pound

Regressors	Study period 1991:Q1-2006:Q2	Dependent variable REER (S) Coefficient [ <i>t</i> -ratio]	
		Pre AFC 1991:Q1-1997:Q2	During and post AFC 1997:Q3-2006:Q2
$ECM_{(-1)}$	-0.5848 [-7.061]***	-0.1543 [-6.668]***	-0.5567 [-4.123]***
$\Delta R$	0.0883 [2.233]**		0.1417 [4.197]***
$\Delta R^*$	0.2608 [4.293]***	0.2055 [3.584]**	-0.1009 [-3.274]**
$\Delta M1$		0.2431 [3.384]**	0.1215 [4.281]***
$\Delta G$	0.5863 [3.102]**	-0.8649 [-4.050]**	
$\Delta \pi$		-0.1455 [-1.790]*	-0.0726 [-1.909]*
$\Delta NFA$	0.0605 [5.024]***		
$\Delta TOT$	0.6047 [6.575]***		
$C$	0.0967 [1.799]*	0.4154 [10.70]***	0.2966 [3.901]**
$\bar{R}^2$	0.8359	0.7527	0.7794
SE	0.0269	0.0135	0.0239
$S^2$ resid	0.0385	0.0033	0.0166
<i>F</i> -statistic	12.71	15.81	7.262
DW-statistic	1.889	2.357	1.748
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

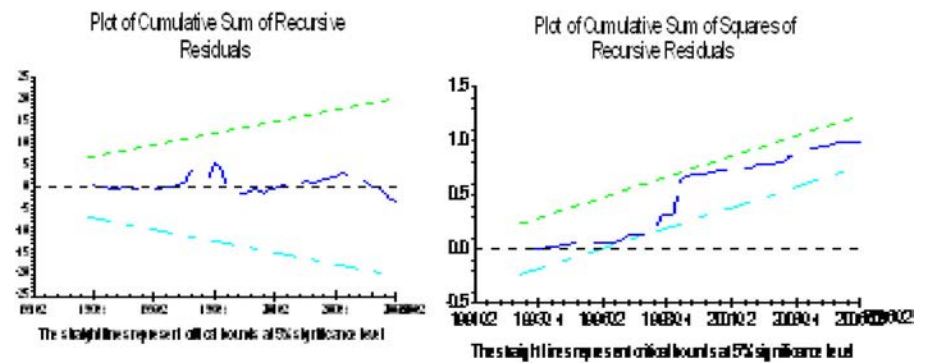
**Table IX.**  
Error correction  
representation based  
on the ARDL model:  
Short-Run Estimation  
for Thailand REER  
via the British Pound

the domestic money supply ( $M1$ ) and  $TOT$ . The second forcing variable in determining the Philippines short-run PPP of REER is the inflation rate ( $\pi$ ). The statistics in Table IX indicate that its significant short-run forcing variables on Thailand PPP of REER throughout the study sub-period and the full period are observed to be the foreign interest rate ( $R^*$ ), while variables  $R$ ,  $M1$ ,  $G$  and  $\pi$  jointly serve as the second force in determining Thailand's short-run PPP of REER. In Table X, results indicate that the key short-run forcing variables of PPP of Singapore REER throughout the study before the crisis and the full period are the foreign interest rate ( $R^*$ ) and  $NFA$ .

**Table X.**  
Error correction  
representation based  
on the ARDL model:  
short-run estimation  
for Singapore REER  
via the British Pound

Regressors	Study period 1991:Q1-2006:Q2	Dependent variable REER (S) Coefficient [ <i>t</i> -ratio]	
		Pre AFC 1991:Q1-1997:Q2	During and post AFC 1997:Q3-2006:Q2
$ECM_{(-1)}$	-0.2000 [-2.409]**	-0.4496 [-2.737]**	-0.3172 [-2.907]**
$\Delta R$	-0.0364 [-1.737]*		
$\Delta P^*$	0.1742 [5.147]***	0.2019 [4.868]***	
$\Delta M1$			
$\Delta G$			0.2122 [2.585]**
$\Delta \pi$	-0.04776 [-2.638]**		
$\Delta NFA$	0.1071 [2.770]**		0.6547 [1.876]*
$\Delta TOT$		0.1365 [2.667]**	
$C$	0.0566 [3.086]**	0.0531 [2.062]*	0.0620 [2.607]**
$\bar{R}^2$	0.8208	0.7234	0.7179
SE	0.0098	0.0089	0.0085
$S^2$ resid	0.0051	0.0015	0.0022
<i>F</i> -statistic	10.11	18.93	5.916
DW-statistic	2.093	1.760	2.054
The period no. of obs.	1991:Q2-2006:Q2 (61)	1991:Q2-1997:Q2 (25)	1997:Q3-2006:Q2 (35)

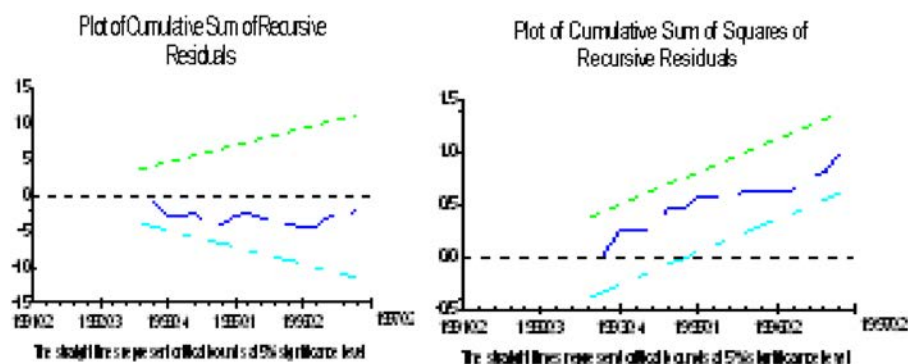
Finally, we examine the stability of the long run parameters together with the short-run movements for each equation. To this end, we relied on cumulative sum (CUSUM) and cumulative sum square (CUSUMSQ) tests proposed by Brown *et al.* (1975). The same procedure was applied by Pesaran and Pesaran (1997) and Bahmani-Oskooee and Ng (2002) to test the stability of the long-run coefficients. The tests applied to the residuals of the ECM models (Tables VI-X) along with the critical bounds are graphed in figures. As can be seen in Figures 1-15, the plots of CUSUM and CUSUMSQ statistics stayed within the critical 5 per cent bounds for all equations. Neither CUSUM nor CUSUMSQ plots crossed the critical bounds, indicating no evidence of any significant structural instability. These results were the same no matter which selection criterion was chosen, which indicated that REER functions in the ASEAN-5 countries against the UK pound were stable. They appeared to be unaffected by the recent financial crisis over the sample sub-periods and full period.



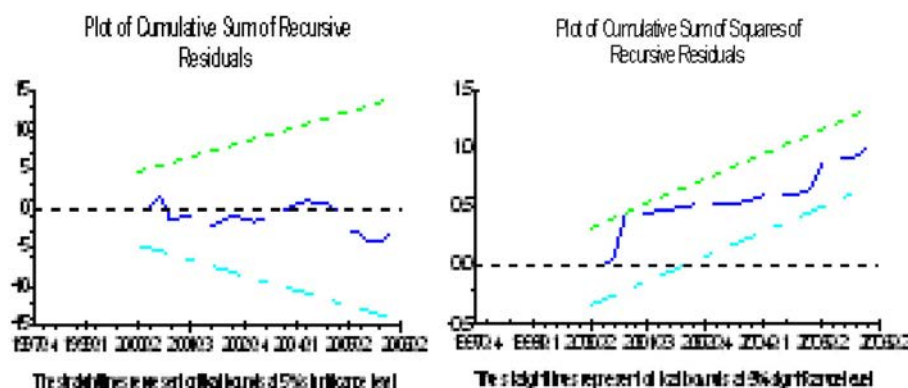
**Figure 1.**  
Plots of CUSUM and  
CUSUMSQ statistics for  
Malaysia via UK REER  
1991:Q1-2006:Q2

## Summary and conclusions

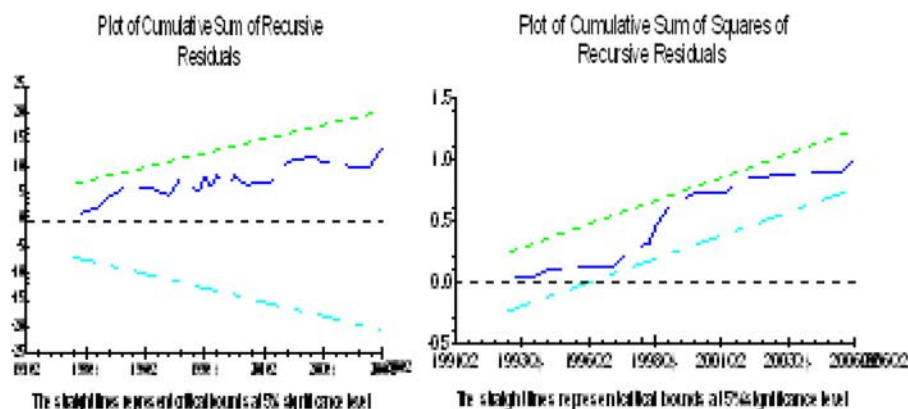
In this paper, we examined the long-run and short-run forcing variables of domestic interest rate, foreign interest rate, inflation rate, domestic money supply, NFA, TOT and RGDP upon REER in ASEAN-5 countries against the UK pound. The long-run



**Figure 2.**  
Plots of CUSUM and CUSUMSQ statistics for Malaysia via UK REER 1991:Q1-1997:Q2



**Figure 3.**  
Plots of CUSUM and CUSUMSQ statistics for Malaysia via UK REER 1997:Q3-2006:Q2

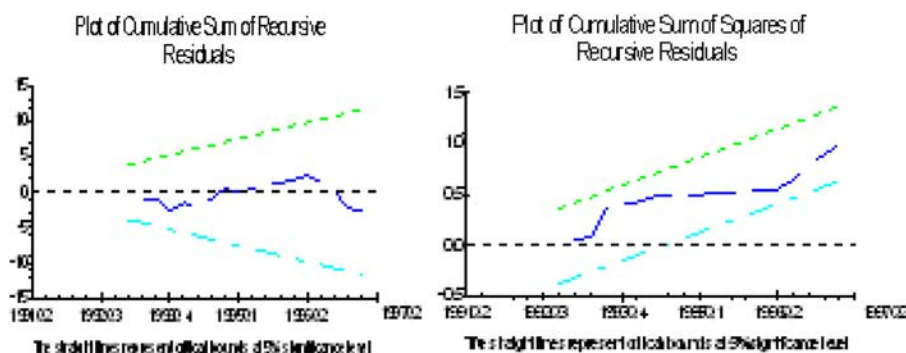


**Figure 4.**  
Plots of CUSUM and CUSUMSQ statistics for Indonesia via UK REER 1991:Q1-2006:Q2

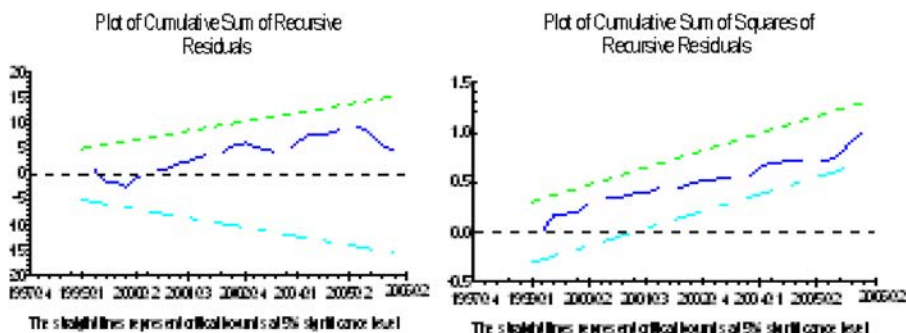
and short-run forcing variables of PPP for ASEAN-5 differ due to their different economic environments and this concurs with the results of Che and Mansur (2006).

The estimated long-run parameters of the ASEAN-5 exchange rate model show that most of the variables carried the correct expected signs and their coefficients are statistically different from zero at conventional significance levels. The results suggest that the foreign interest rate ( $R^*$ ) and domestic money supply (M1) are the greatest forcing variables of PPP for ASEAN-5 REERs for the three periods. The short-run Malaysian results suggest that the domestic money supply (M1) is the highest forcing

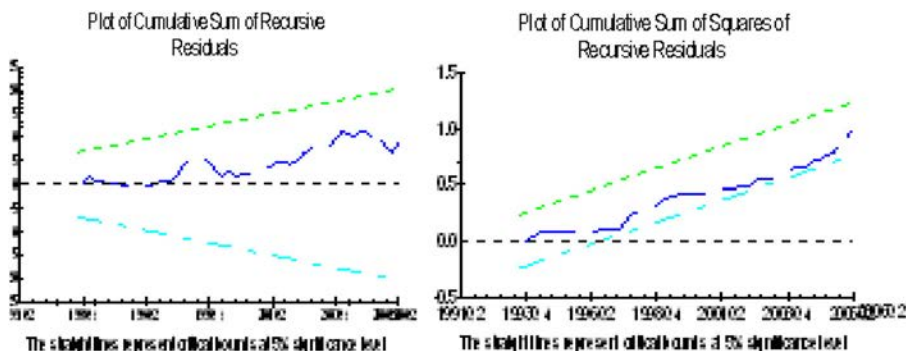
**Figure 5.**  
Plots of CUSUM and CUSUMSQ statistics for Indonesia via UK REER1991:Q1-1997:Q2

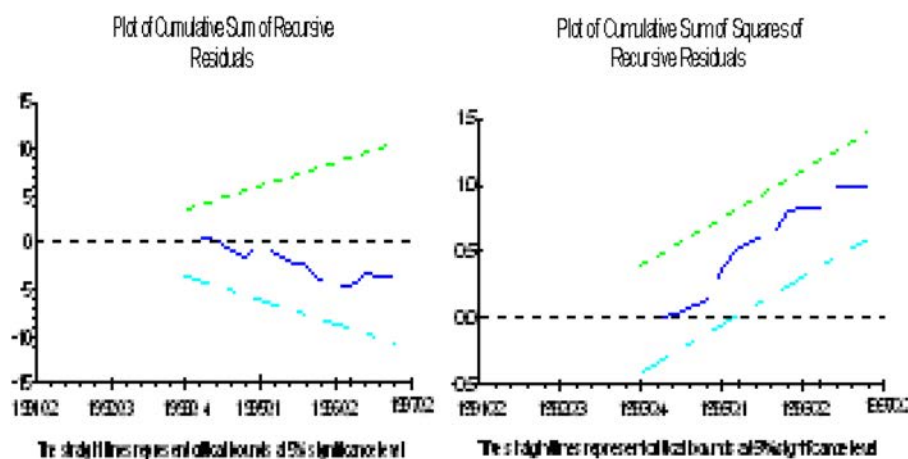


**Figure 6.**  
Plots of CUSUM and CUSUMSQ statistics for Indonesia via UK REER 1997:Q3-2006:Q2

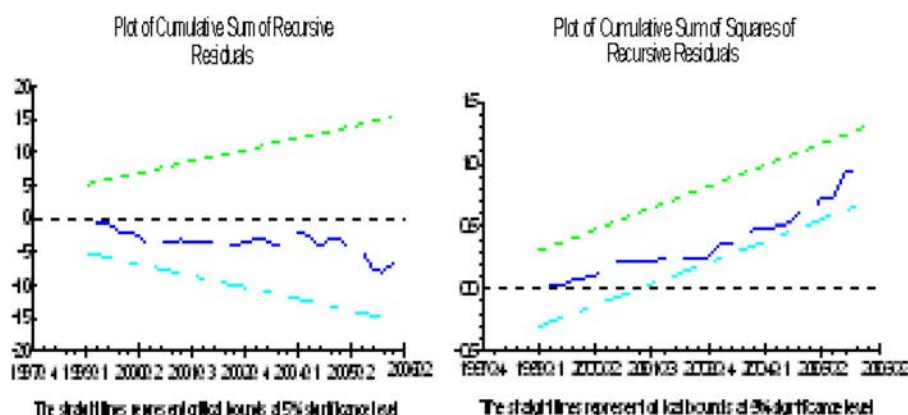


**Figure 7.**  
Plots of CUSUM and CUSUMSQ statistics for Philippines via UK REER 1991:Q1-2006:Q2

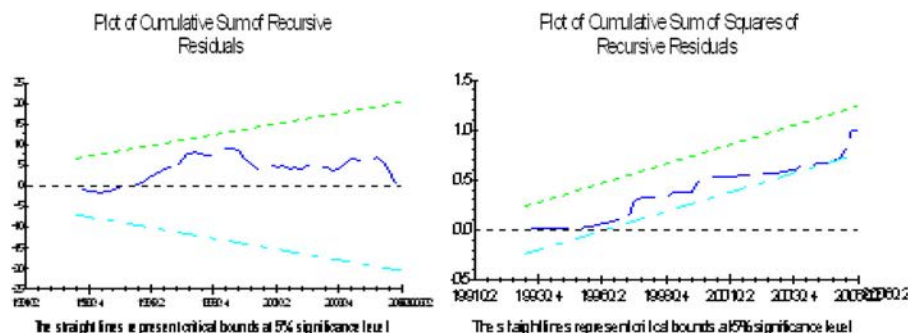




**Figure 8.**  
Plots of CUSUM and  
CUSUMSQ statistics  
for Philippines via UK  
REER 1991:Q1-1997:Q2



**Figure 9.**  
Plots of CUSUM and  
CUSUMSQ statistics  
for Philippines via UK  
REER 1997:Q3-2006:Q2



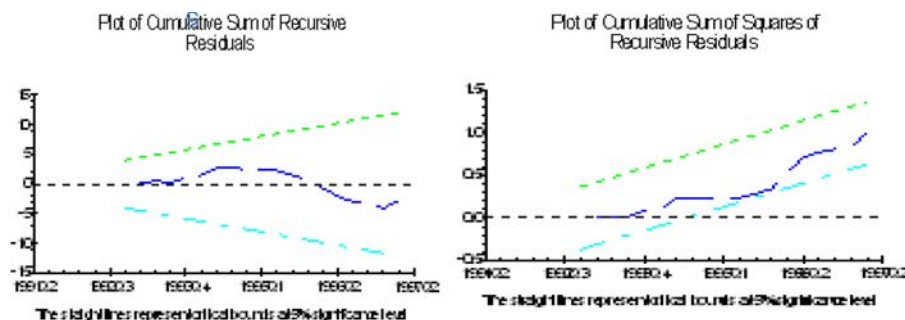
**Figure 10.**  
Plots of CUSUM and  
CUSUMSQ statistics for  
Thailand via UK REER  
1991:Q1-2006:Q2



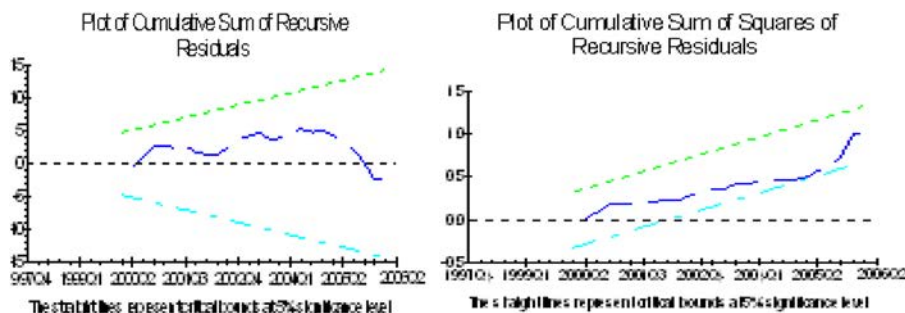
element of PPP for Malaysia's REER during the sub-periods and the full period. The impact of the M1 on Malaysia's PPP long runs is due to the development of its own financial system, its degree of openness and its small size.

The estimated results for the short-run of the REER model for Indonesia suggests that the  $R$ ,  $R^*$  and  $G$  are the highest forcing variables of PPP on Indonesia's REER for the three periods, while the second forcing variable on Indonesia's REER is the domestic money supply (M1). However, the impact of M1 upon Indonesia's PPP is due to major exports of natural resources. The results for the Philippines suggests that domestic money supply (M1) and TOT are significant influences on the Philippines'

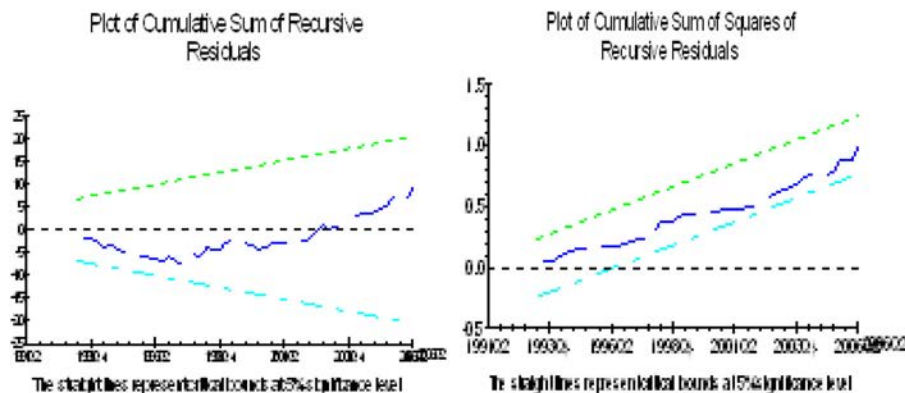
**Figure 11.**  
Plots of CUSUM and  
CUSUMSQ statistics for  
Thailand via UK REER  
1991: Q1-1997:Q2



**Figure 12.**  
Plots of CUSUM and  
CUSUMSQ statistics  
for Thailand via UK  
REER 1997:Q3-2006:Q2

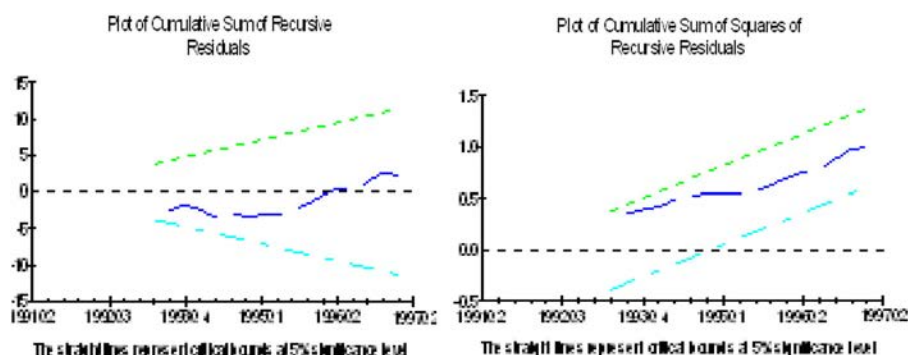


**Figure 13.**  
Plots of CUSUM and  
CUSUMSQ statistics for  
Singapore via UK REER  
1991:Q1-2006:Q2

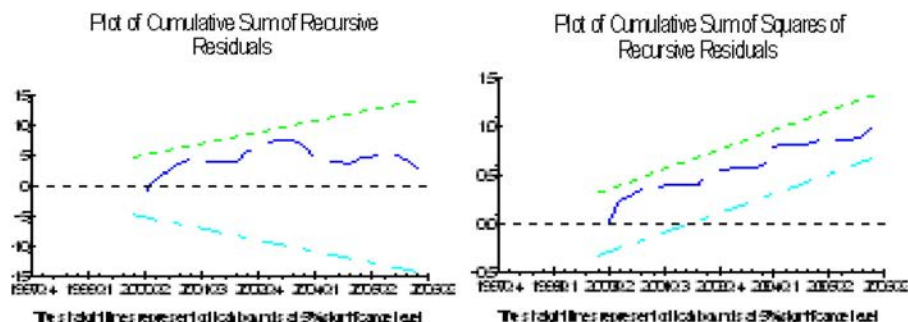


PPP for the three periods. Statistics for the Thailand results suggest that the short-run forcing variables of PPP of Thailand's REER is foreign interest rate ( $R^*$ ). Variables  $R$ ,  $M1$ ,  $G$  and  $\pi$  then jointly serve as the second force on Thailand's REER. The impact of  $R^*$  upon Thailand's PPP is due to the IMF and the World Bank's requirement that Thailand opens its traditional closed economy before it can be assisted. Singapore's results indicate that the key short-run forcing variables of PPP of REER throughout the study period are the foreign interest rate ( $R^*$ ) and the NFA. The impact of  $R^*$  and NFA upon Singapore's PPP is due to its openness, its small size, and its well developed financial sector in Singapore, followed by Malaysia's financial situation when compared to other ASEAN-5 financial markets.

Finally, our empirical results are also in line with those of the World Bank researchers, who found that in general, the developing economies are heterogeneous. Thus, the long run forcing variable of PPP should differ accordingly to countries' economic environments. The result are also similar to the empirical findings of Frenkel (1976, 1978), MacDonald and Taylor (1994), Chinn and Meese (1995), Kanas (1997), Husted and MacDonald (1998), Dutt and Gosh (1999), Francis *et al.* (2001), Caporale *et al.*, 2001, Rapach and Wohar (2002), Groen and Kleibergen (2003) and Chaboud and Wright (2005). Thus, the policy makers in the respective ASEAN-5 economies need to constantly identify the long-run forcing variables. The long run forcing variables are essential to the policy makers to assess, manage and develop the financial sector in order to play a more vital role in promoting their respective economic growth.



**Figure 14.**  
Plots of CUSUM and  
CUSUMSQ statistics for  
Singapore via UK REER  
1991:Q1-1997:Q2



**Figure 15.**  
Plots of CUSUM and  
CUSUMSQ statistics for  
Singapore via UK REER  
1997:Q3-2006:Q2

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